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PATENT APPLICATION

A SYSTEM FOR USE IN CONTROLLING A HYDROCARBON PRODUCTION WELL

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Cross-Reference to Related Application

[0001] This application claims the benefit of United Kingdom Patent Application No. 0228203.6, filed on December 3, 2002, which hereby is incorporated by reference in its entirety.

Technical Field of the Invention

[0002] The present invention relates to a system for use in controlling a hydrocarbon production well.

Background of the Invention

[0003] In the subsea fluid extraction industry, communication is required between a control centre and well heads located on the seabed. Traditionally, the control centre is located on a platform or vessel in relatively close proximity to the well complex. In some cases, the control centre is located on land, where the distance from the control centre to the well heads can be much greater and could be typically 200km. High capacity communication systems, typically involving optical fibres, allow the possibility of much higher data rates between the subsea and surface facilities, which further enables methods of connecting subsea data sources (e.g. sensors),

particularly those generating large quantities of data such as microseismic sensors and TV cameras.

[0004] A conventional approach is to use a standard subsea bus at the well head ends of a data transmission system to connect such various subsea data sources. This means that any other party providing equipment to the system has to interface with the bus and conform to its protocol, data rates and bus standards. Since different manufacturers have standard equipment with interfaces to a multiplicity of protocols and data rates, substantial costs are involved in adapting these interfaces to suit the standard bus. Furthermore, since this data is time multiplexed on the bus, the data rates are also somewhat limited such that some desirable, high bandwidth, data transmissions, such as digital video signals, cannot be economically transmitted.

[0005] Fig. 1 shows a conventional system for the communication of data between subsea well trees and a surface facility. Mounted on each of a number of subsea well trees (not shown) is a subsea electronics module (SEM) 1 including a SEM processor 2, which handles at a port 3 data from conventional tree sensors such as pressure and temperature and at a port 4 data for control of devices such as valves and fluid control chokes, there being a port 5 for a standard interface for data from other subsea data sources. The SEM processor 2 communicates bi-directionally with a surface facility computer system 6 (on shore or on a platform for example) via a modem 7 housed in the SEM 1, a communication link 8 and a modem 9 housed in a surface modem unit (SMU) 10 at the surface facility. The communication link 8 enables communication with the SEMs of other well trees and at some or all of the well trees there is system duplication to improve system availability - thus in Fig. 1 there are shown two SEMs (SEM A1 and SEM B1) for a particular well tree, SEM A2 and SEM B2 representing duplicate SEMs for another tree.

[0006] When the surface computer 6 is located at a considerable distance, such as, typically, 200km from the well complex, a fibre optic link is used as link 8 to transmit data between the or each SEM at a well tree to the surface computer 6. Nevertheless, the data from other sources at port 5 needs to be adapted to the protocol, data rates and other standards used for the communication of control information and sensor information.

Summary of the Invention

[0007] According to the present invention, there is provided a system for use in controlling a hydrocarbon production well, comprising computing means at a control location remote from a well tree of the well. The system also has a well tree means has a processing means for applying control signals to and receiving signals from devices of the well tree. The well tree means includes means for receiving further signals associated with the operation of the well. A bi-directional communication link exists between said computing means and said well tree means.

[0008] The well tree means further comprises a communications router coupled with said processing means and said receiving means, for multiplexing said signals from devices at the well head and said further signals on to said bi-directional link. The bi-directional link could comprise a fibre optics link.

[0009] There could be a plurality of such well tree means at respective well trees, there being a distribution means between said bi-directional link and the well tree means for distributing control signals to said well tree means and receiving multiplexed signals from said well tree means.

[0010] The signals from devices at the well head and further signals could have different protocols and different data speeds. The further signals could include video signals.

[0011] The present invention also comprises a combination of a system according to the invention providing a first communication channel, and a further such system, providing a second communication channel for use if the first channel fails.

Brief Description of the Drawings

[0012] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

[0013] Fig. 1 is a diagram of a prior art form of system for use in controlling a hydrocarbon production well;

[0014] Fig. 2 is a diagram of an example of a system according to the present invention;

[0015] Fig. 3 is a diagram of another example of the present invention; and

[0016] Fig. 4 is a diagram showing part of an alternative to what is shown in Fig. 3.

Detail Description of the Preferred Embodiment

[0017] Fig. 2 (in which items which correspond with those in Fig. 1 have the same reference numerals as in Fig. 1) illustrates a system according to an example of the invention, showing linking from a surface computer 6 to a well tree. The surface computer 6 at the control centre (on shore or on a platform for example) sends and receives data to and from a surface modem unit (SMU) 10 which houses a modem 9. This modem 9 transmits and receives data via a communication link 8. The other end of the communication link 8 connects to the well head tree which carries a subsea electronics module (SEM) 11 which houses a modem 7 which is a similar device to the modem 9 and performs the opposite function. The modem 7 has an electrical output/input, which is connected to a communications processor 12 which functions as a communications router (or intelligent multiplexer), also housed in the SEM 11. The communications router 12, has a multiplicity of inputs/outputs, there being an interface with a conventional SEM processor 2 (having sensor, control and standard interface ports 3, 4 and 5) and also interfaces 13 which interface with other 'private' standard interfaces known as virtual links. The interfaces are effectively 'star connected' rather than the conventional 'highway connected' and virtually any protocol and data rate can be handled, limited only by the router 12, speed and the final limitation of the bandwidth of the communication link 8 and its modems 7 and 9. Typically, the link 8 could be about 200km in length, data being transmitted via it at typically 10Mbits/sec. The software in the router 12 is flexible and handles, by multiplexing, the data and protocol of the 'private' interfaces, as required for the system configuration, to permit high speed communication to and from the modem 7, thereby providing virtual links between the surface and subsea equipment. The SEM processor 2 handles the conventional control of subsea devices, such as valves and chokes, to control the fluid extraction process. It also handles local logging and processing of data from the tree sensors, its main functions being to acquire data

from the sensors and assemble it into a format that can be transmitted to the surface computer and to issue control signals to valves and fluid control chokes for example.

[0018] Typical of the above-mentioned private, standard interfaces are the intelligent well system interface, (IWS) (an Ethernet interface), and others as shown in Fig. 2 which are well known in the industry, as well as interfaces to devices such as level sensors, microseismic sensors and fluid quality sensors. Due to the fact that the system configuration allows high bandwidth utilisation of the communication link 8, typically a fibre optic link, it is possible to transmit compressed video. This allows the fitting of cameras to the subsea well head, to permit visual inspection of the tree without the need for expensive diving operations or the use of a remote operation vehicle (ROV). This will have major benefits to the well operator who, in the past, has had to rely on sensor information to prompt the deployment of divers or a ROV to effect a visual inspection, but can now have a continuous visual inspection facility.

[0019] Fig. 3 (in which items which correspond with those in Fig. 2 have the same reference numerals as in Fig. 2) shows a typical full system implementation to handle communication between a control centre and a subsea well complex, and providing high availability through dual duplex redundancy. The figure shows a high end application with a large amount of redundancy and long distance offsets with a subsea central distribution system arrangement that sits between a surface computer and well head control modules.

[0020] Two separate communication channels are provided, A and B, to provide 100% redundancy. Describing channel A, a surface computer 6 at the control centre (on shore or on a platform for example) feeds and receives data to and from an SMU 14 which houses two bi-directional optical modems 15 and 16.

[0021] The optical modems 15 and 16 interface with respective ones of a pair of optical fibres 17 and 18, which terminate near to a well head complex at a communication electronics module (CEM) 19 typically located on the seabed. Typically, the communication link provided by the optical fibres could be about 200km, data being transmitted via them at typically 10Mbits/sec. The CEM 19 enables interfacing of many wells in the locality with the optical fibres 17 and 18. The use of two optical fibres provides further redundancy and thus greater communications reliability. The CEM 19 houses another two bi-directional optical modems 20 and 21 coupled with respective ones of fibres 17 and 18 and which output electrical signals to a communications router 22. The communications router 22 interfaces with electrical modems, of which three, 23, 24 and 25 are shown, by way of example, each of which interfaces with a modem of a SEM at a well tree. Thus, for example, the modem 23 interfaces with a modem 7 of a SEM 1 via a communication link 26 and with the modems at other trees within the group via a communication link 27 and modems 24 and 25 interface with modems at other groups of trees via communication links 28 and 29.

[0022] Fig. 3 also shows a duplicated identical channel B for use instead of channel A for further reliability. In the event of failure of both channels, rudimentary communication is provided by a link 30 from the computer 6 of each channel, a low speed communications modem (LSCM) 31, a back-up communication link 32 (typically operating at 1.2 kbits/sec) and a link 33 for each channel, each link being coupled by a LSCM 34 to the communications router 22 of the respective channel.

[0023] It should be noted that each of modems 23, 24, 25, etc. and each of the corresponding modems at the well tree SEM's, may, alternatively, be of the form that communicates via the electrical power supply to the tree, i.e. a comms-on-power (COP) type of modem.

[0024] Fig. 4 shows part of an alternative to the system of Fig. 3, items which correspond with items in Fig. 3 having the same reference numerals as in Fig. 3. Instead of a single back-up communication link, each channel has its own back-up communication link 35 (typically operating at 1.2kbits/sec), being a link which provides subsea power from a 3-phase, 3kv supply and each channel having a respective LSCM 36 instead of there being a single LSCM 31 as in Fig. 3. In Fig. 4, modems 23, 24 and 25 are COP modems.

[0025] While the invention has been shown in only a few of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes without departing from the scope of the invention.